image aberrations, a focusing lens 103 receiving light from the group 101 for producing an intermediate image 105, a field lens 107 of the same material as the other lenses placed at the intermediate image 105, a thick lens 109 with a plane mirror back coating 111 whose power and position is selected to correct the primary longitudinal color of the system in conjunction with the focusing lens 103, and a spherical mirror 113 located between the intermediate image and the thick lens 109 for producing a final image 115. Most of the focusing power of the system is due to the spherical mirror 113. It has a small central hole 117 near the intermediate image 105 to allow light from the intermediate image 105 to pass therethrough to the thick lens 109. The mirror coating 111 on the back of the thick lens 109 also has a small central hole 119 to allow light focused by the spherical mirror 113 to pass through to the final image 115. While primary longitudinal (axial) color is corrected by the thick lens 109, the Offner-type field lens 107 placed at the intermediate image 105 has a positive power to correct secondary longitudinal color. Placing the filed lens slightly to one side of the intermediate image 105 corrects tertiary longitudinal color. Thus, axial chromatic aberrations are completely corrected over a broad spectral range. The system incidentally also corrects for narrow band lateral color, but fails to provide complete correction of residual (secondary and higher order) lateral color over a broad UV spectrum.

C1 fr

Please replace pg. 4, line 6, with the amended text below. A "marked-up" version of each amendment is included in **Attachment A**.

C2

Summary of the Invention

Please replace pg. 9, line 32 - pg. 10, line 19, with the amended paragraph below. A "marked-up" version of each amendment is included in **Attachment A**.

C3

The catadioptric group 17 seen in Fig. 1 includes a first optical element consisting of a fused silica meniscus lens 39 with a concave reflective surface coating 41 on a back surface of the lens 39, and also includes a second optical element consisting of a fused silica lens 43 with a reflective surface coating 45 on a back surface of the lens 43. (The front surfaces of the two lens elements 39 and 43 of the catadioptric group 17 face each other.) The reflective surface coatings 41 and 45 are typically composed of aluminum, possibly with a MgF_2 overcoat to prevent oxidation. Aluminum has a nearly uniform reflectivity of at least 92% over the entire near and deep UV wavelength range. Other metals commonly used as reflective coatings in the visible portion of the spectrum have reflectivities that vary considerably with wavelength or even become opaque in the deep UV. For example, silver drops to only 4% reflectivity at 0.32 μm.

Possible alternative to aluminum, but with somewhat lower reflectivities near 60%, include molybdenum, tungsten and chromium. These may be favored in certain high power applications, such as laser ablation. Specialized coatings, including long-wave pass, short-wave pass and band pass dichroic reflective materials, partially transmissive and reflective material coatings, and fluorescent coating, could all be used for a variety of specialized applications.

C3 end

Please replace pg. 11, lines 13-27, with the amended paragraph below. A "marked-up" version of each amendment is included in **Attachment A**.

C4

Light from the intermediate image 13 passes through the optical aperture 37 in the first lens 39 then through the body of the second lens 43 where it is reflected back through the body of the second lens 43 by the planar or near planar mirror coating 45 on the back surface of the lens 43. The light then passes through the first lens 39, is reflected by the mirror surface 41 and passes back through the body of the first lens 39. Finally the light, now strongly convergent passes through the body of the second lens 43 for a third time, through the optical aperture 47 to the final image 19. The curvatures and positions of the first and second lens surfaces are selected to correct primary axial and lateral color in conjunction with the focal lens group 11.

Please replace pg. 15, lines 1-25, with the amended paragraph below. A "marked-up" version of each amendment is included in **Attachment A**.

C5

With reference to Fig. 4, a tube design for using the imaging system of Fig. 1 as a microscope objective is shown. Illumination of a sample surface being imaged by the objective of Fig. 1 may be made through the object itself, by means of an ultraviolet light source 61, such as a mercury vapor lamp or excimer laser, together with conventional illumination optics 63, 65, 67, leading to a beamsplitter 69 in the objective's optical path. The imaging path for light received from the objective of Fig. 1 is via transmission through the beamsplitter 69 to a microscope tube, whose design may also be catadioptric. The tube elements include a pair of opposite facing negative meniscus lenses 71 and 73 closely spaced to one another, and two spherical mirrors 75 and 77 spaced from each other and from the pair of lenses 71 and 73 by at least 400 mm. The curvature of mirror 75 is concave toward the lenses 71 and 73 and the mirror 77, while the curvature of mirror 77 is convex toward the mirror 75, both curvatures being at least 1000 mm radius, i.e. nearly flat. The mirrors 75 and 77 fold the optical path off-axis so that the system

C5 (cont'd)

length is under 500 mm. One example optimized for the particular objective seen in Fig. 1 has the following characteristic refractive and reflective surfaces for optical elements 71, 73, 75, and 77:

Please replace pg. 16, lines 1-26, with the amended paragraph below. A "marked-up" version of each amendment is included in **Attachment A**.

C6

Referring now to Fig. 5, yet another use for the imaging system of Fig. 1 is for wafer inspection, namely as a directional dark field, scattered light collector. A UV laser illumination source 81 directs a beam 85 through holes 83 and 87 formed in lenses 39" and 43" and reflective coating 41" and 45" of the catadioptric group onto a surface 89 to be inspected. Alternatively, only the reflective coating 41" and 45" might be absent or only partially reflective to form transparent or at least partially transmissive windows for the light beam 85. The beam 85 might also enter the system from below the hemispherical reflector 41". The angle of incidence is oblique, i.e. at least 60° from vertical due to the high numerical aperture (about 0.90) of the imaging system. Illumination may be done from more than one direction and angle of incidence. The specularly reflected light 93 passes through holes 91 and 95 formed in lenses 39" and 41" and reflective coatings 41" and 45" of the catadioptric group (or in the coatings 41" and 45" only). UV light scattered by features on the sample surface 89 are imaged by the catadioptric imaging system of Fig. 1, beginning with the catadioptric group, then through the achromatic field lens group, and focusing lens group, to the tube elements 71, 73, 75 and 77 of the tube system (absent the illumination group 61, 63, 65, 67 and 69).

Please replace pg. 17, lines 9-34, with the amended paragraph below. A "marked-up" version of each amendment is included in **Attachment A**.

C7

Fig. 6 shows a wafer inspection apparatus that can use the catadioptric imaging system as a UV objective 86 for the apparatus. The apparatus may be constructed according to one or more of U.S. Patents 4,247,203; 4,556,317; 4,618,938; and 4,845,558 of the assignee of the present invention. A semiconductor wafer 82 with a plurality of integrated circuit die 84 at some stage of formation on the wafer 82 is shown lying in a carrier or stage 80. The stage 80 is capable of providing movement of the wafer 82 with translational X and Y and rotational θ motion components relative to a UV microscope objective 86, such as the catadioptric imaging system seen in Fig. 1. Light 88 collected from a die 84 or a portion of a die and formed into a magnified image of that die or portion by the objective 86 is transferred through a relay lens or lens system 90, such as the tube lens system seen in Fig. 4, into the aperture of a video or

CCD array camera 92 sensitive to deep UV light. The output 94 of the camera 92 is fed into a data processor 96, which compares pixel data relating to the UV image of the die or die portion either to data corresponding to other portions of the image or to stored data from previous images relating to the die or other die portions. The results of this comparison are fed as data 98 to an output device, such as a printer or a CRT display, or to a data storage unit.

C7 end

Please replace pg. 20, lines 7-31, with the amended paragraph below. A "marked-up" version of each amendment is included in **Attachment A**.

C8

The depth of focus of an optical system (proportional to wavelength and inversely proportional to the square of the system's numerical aperture) is intrinsically very short in the ultraviolet spectrum (typically on the order of 0.1 to 0.5 μm). This can create a problem in imaging patterned wafers and other similar surfaces with nonplanar profiles. With the broadband UV optics of the present invention, we can use multiple UV wavelength imaging at different depths and computer software integration of the resulting images to extend the depth of focus to about 1 μm. For example, we can scan the surface of a wafer or other object at three different UV colors with about a 10 to 50 nm wavelength separation (e.g., at 0.20, 0.22 and 0.24 μm) using three different focal planes for the different wavelengths to image different slices of the surface. A confocal microscope configuration with the UV objective of the present invention and with three detectors having corresponding bandpass filters could be used for this purpose. The three images can then be integrated by a computer to produce a composite with the increased depth of focus. The small depth of focus of the high N.A. lens systems can also be used to advantageously produce high resolution image slices at various depths than can be integrated to form a 3-D image.

IN THE DRAWINGS

Submitted herewith in a separate paper is a Request for Approval of Drawing Changes. The Examiner's review and approval of the changes to Fig. 3 is solicited. The changes are submitted for clarification and consistency with the Specification and, as such, do not present new matter.

IN THE CLAIMS

Please replace claims 21, 29-32, 34, 36, 37, and 39 with the amended claims below. A "marked-up" version of each amendment is included in **Attachment A**.